(19) FRENCH REPUBLIC

(11) Publication number: **2 602 114**
(use only for reproduction orders)

NATIONAL INSTITUTE FOR INDUSTRIAL PROPERTY

(21) National registration number: **86 10682**

(51) Int Cl^4 : H 05 B 6/64

PARIS

(12) **Application for Invention Patent A1**

(22) Filing date: 23 July 1986

(30) Priority:

(43) Date of public availability of application: BOPI « Brevets » No. 4 of 29 January 1988

(60) References to other related national documents:

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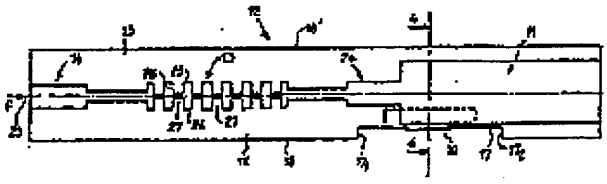
(54) Microwave Oven with Harmonics Rejection Filter

(57) Microwave oven comprising a hyperfrequency wave generator, such as a magnetron. To eliminate the first harmonics of the signal produced by the generator, it contains, between the output of the latter and the cooking cavity, a filter 13 formed within a waveguide 12. This filter 13 for instance includes columns or projections 27 on each side of a median plane 23.



MICROWAVE OVEN WITH HARMONICS REJECTION FILTER

The invention pertains to a microwave oven. A microwave oven comprises a generator of electromagnetic waves, generally a magnetron with a frequency of 2.45 GHz. These hyperfrequency waves circulate in the cavity constituted by the oven to heat or cook food.

Due to the danger presented by the hyperfrequency waves, the oven must be sealed against these waves. The seal is well secured for the 2.45 GHz frequency. But most of the time the magnetron creates harmonics at higher frequencies and therefore at shorter wavelengths for which the seal is much less secure. The fifth harmonic is particularly inconvenient because it falls in the reception range of television broadcasts emitted by geostationary satellites; this harmonic thus runs the risk of disturbing the reception of such broadcasts.

To solve this problem, it has been suggested until now to improve the signal quality of the magnetron and to improve the security of the oven's seal. But these solutions are costly, which is a particular disadvantage in the case of a mass produced appliance.

The invention removes these difficulties.

It is characterized in that it comprises, between the output of the hyperfrequency generator and the cooking enclosure, a waveguide containing a filtering section for undesirable harmonics.

In the preferred embodiment the filter is in the form called "waffle iron", that is with two essentially parallel walls with projecting elements symmetrical with respect to a median plane parallel to the two walls. It is thus possible to fabricate the waveguide, notably by molding, from two identical or almost identical half-shells.

Preferrably, to ease removal from the mold, the drafts are relatively large, of the order of 2^{o}, and the edges are rounded. One might have thought that these drafts and rounded edges would deteriorate the quality of the filtering, but it was observed that the quality of the filtering remained entirely satisfactory up to the seventh harmonic.

In one embodiment the filter type is uniform, all the projections being identical. In a variant for a better filtering quality, while maintaining symmetry with respect to a median plane, the projections are not all identical to each other at least with respect to their cross section and their length. In this case, each half-shell has not one but several faces forming a stair pattern.

Other characteristics and advantages of the invention will appear with the description of some of its embodiments, a description that will refer to the appended drawings in which:

– figure 1 is a longitudinal transversal cut of a waveguide for microwave ovens according to the invention,

– figure 2 is plan view of a first part of the figure 1 waveguide,

– figure 3 is a plan view of the second part of the figure 1 waveguide,

– figure 4 is a cross section along line 4-4 of figure 1,

– figure 5 is a view along arrow F of figure 1,

– and figures 6 and 7 are views analogous to those of figures 1 and 2 but pertaining to a variant.

According to the invention, the hyperfreqency waves produced by the magnetron of a microwave oven (not shown) are supplied to an antenna introduced through a hole 10 in the input section 11 of a waveguide 12. The input 11 provides a match of the waveguide to the antenna. In addition, upstream of input 11, this waveguide contains a filtering section 13, and then at the output, another matching section 14 opening out into the cooking enclosure (also not shown).

The general shape of the waveguide is that of a rectangular parallelepiped. It consists of two pieces or half-shells 15 and 16 formed by an aluminum-based alloy casting. These half-shells have practically identical internal shapes except for hole 10 in half-shell 16 which is not present in half-shell 15. Other differences to be noted between the units 15 and 16 in the example, are that outside, around hole 10, half-shell 16 has a recess 17 consisting of a transversal groove present on the large external face 18 of the half-shell 16, with transversal extremities 17_1 and 17_2. This groove allows the positioning and attachment of an antenna support 19.

In the example, the thicknesses of the small-surface longitudinal walls are unequal for the units 15 and 16. Figure 5 thus shows that the longitudinal wall 20 of half-shell 16 is less thick than the longitudinal wall 21 of half-shell 15.

The two longitudinal walls 21 and 21' of the half-shell 15 fit between the longitudinal walls 20 and 20' of the half-shell 16.

Each of these longitudinal walls 20, 21, 20', 21' includes coaxial through-holes 22 (figure 4) allowing the insertion of assembly screws for the two half-shells 15 and 16.

The internal faces of the two half-shells 15 and 16 are symmetrical with respect to a median plane 23 (figure 1) parallel to the large longitudinal faces 18 and 18'.

The section 11 input includes a large opening and it is attached to filter section 13, whose opening is clearly smaller, by a section 24 of intermediate size.

The filter 13 has the shape of a "waffle iron". It has two faces 25 and 26 in the same plane as the faces parallel to the median plane 23 of the intermediate section 24. Cylinders 27 with a square cross section project out of these faces 25 and 26. In the example these projections are distributed regularly along a square with a side equal to the size (transversal dimension) of the large face of each half-shell. In this example, the distance separating the two faces 27_1 and 27_2 nearest to two projections 27 of a same half-shell is practically equal to the length of the side of the square formed in cross section by this projection.

The filter 13 forms a wave trap that makes it possible to efficiently filter harmonics of the 2.45 GHz wave up to the 8th level. It is thus not necessary to provide specfic means for sealing in order to prevent high level harmonics from escaping out of the cooking enclosure.

All the transversal faces, namely those, 28, of the projections 27 have a relatively large draft, of the order of 2°, to ease removal from the mold. In addition, the various parts, including the projections 27, do not have sharp edges, but rather rounded ones, also in order to ease molding and unmolding. Despite these characteristics unfavorable for filtering, it was noted that the quality of the filter was practically unaffected.

The output section 14 is practically identical to the intermediate section 24 between the input section 11 and the filter 13.

In the example, the waveguide has a length of the order of 40 cm, an overall width of the order of 11 cm, and an overall height of the order of 6 cm. The number of projections in each half-shell is 49, the length of the side of the square formed by the cross section of each projection is 6.5 mm. The height of each projection is 7 mm and the distance separating the faces accross the two projections is of the order of 3 mm.

The embodiment shown in figures 6 and 7 is dissimilar to the one just described in relation to figures 1 to 5 only in the composition of filter 13_1, whose projections or columns are not all identical to each other. However, as in the first example, this filter has a plane of symmetry 23_1, which is the median plane of the waveguide 12_1. In addition, filter 13_1 has: a second plane of

symmetry 30 perpendicular to the longitudinal axis of the waveguide and a third plane of symmetry 31 which contains the longitudinal axis of the waveguide and is parallel to walls 20, 21, 20', 21'.

Because of the symmetry, only one-half of the half-shell 16_1 located upstream of the plane of symmetry 30 will be described.

This half-shell half has three bottom surfaces 32, 33, and 34. Bottom 32 is furthermost from plane 23_1 and closest to plane 30. Bottom 34 is the closest to plane 23 and the most upstream, that is, on the side of the waveguide input.

Bottom 32 has a row of five projections 35 aligned along a direction parallel to plane 30. Each projection 35 has a cylindrical shape and a square cross section.

Bottom 33 has a row of seven projections 36 with square cross sections but with dimensions smaller than those of the projections 35. Similarly, bottom 34 comprises a row of eight projections 38 with square cross sections with smaller dimensions than those of the projections 36.

The projections 36 have a face 39 coplanar with the face 40 separating the bottoms 32 and 33. Similarly, the projections 38 have a face 41 coplanar with the face 42 separating bottoms 33 and 34.

All the extremity faces 43 of the projections 35, 36, 38 are in the same plane parallel to plane 23_1.

In the example, the length of the side of the square of the cross section of each projection 35 is 8.7 mm and the shortest distance between two projections 35 is 18.3 mm. In cross section the length of the side of each projection 36 is 7.3 mm and the length of the side of the square of the cross section 25 of each projection 38 is 5 mm

As in the previous embodiment, the walls perpendicular to plane 23_1 have drafts to ease removal from the mold and the edges separating the walls are rounded.

A filter of the type described in relation to figures 6 and 7, with projections of unequal dimensions, has a greater efficiency for filtering high level harmonics than filter 13 in which all the projections are identical to each other.

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CLAIMS

1. Microwave oven comprising a hyperfrequency wave generator, such as a magnetron, emitting a fundamental component and harmonics, characterized in that it comprises between the output of the generator and the cooking enclosure, a waveguide (12) in which a filtering section (13) is formed to eliminate at least the first harmonics.

2. Microwave oven according to claim 1, characterized in that on each side of a median plane (23, 23_1) the filter (13) has columns or projections (27, 35, 36, 38) preferrably in positions symmetrical with respect to this median plane.

3. Microwave oven according to claim 2, characterized in that the waveguide contains two units (15, 16) on each side of the median plane (23_1).

4. Microwave oven according to claim 3, characterized in that for each unit being formed by casting, the columns or projections have drafts of the order of 2° and no sharp edges.

5. Microwave oven according to any of claims 2 to 4, characterized in that the projections or columns (27) are all identical to each other.

6. Microwave oven according to any of claims 2 to 4, characterized in that the filter (13_1) comprises projections or columns (35, 36, 38) of unequal dimensions.

7. Microwave oven according to any of the preceding claims, characterized in that the fundamental frequency is 2.45 GHz and in that the filter (13, 13_1) eliminates at least the level 5 harmonic.

FIG_1

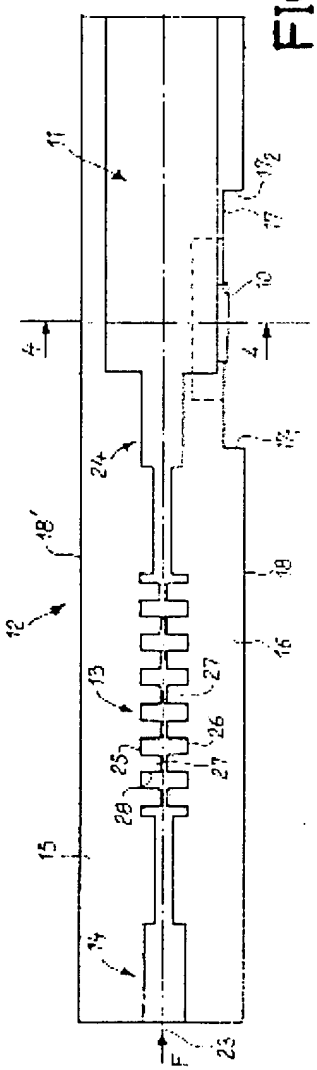
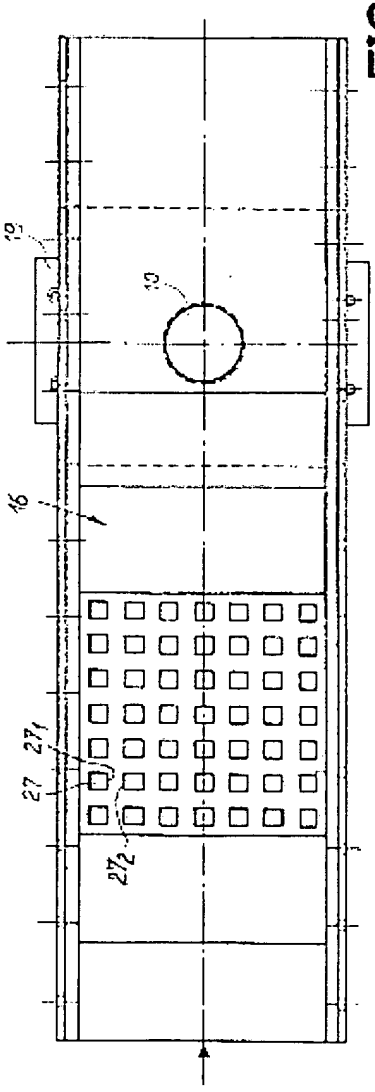


FIG_2



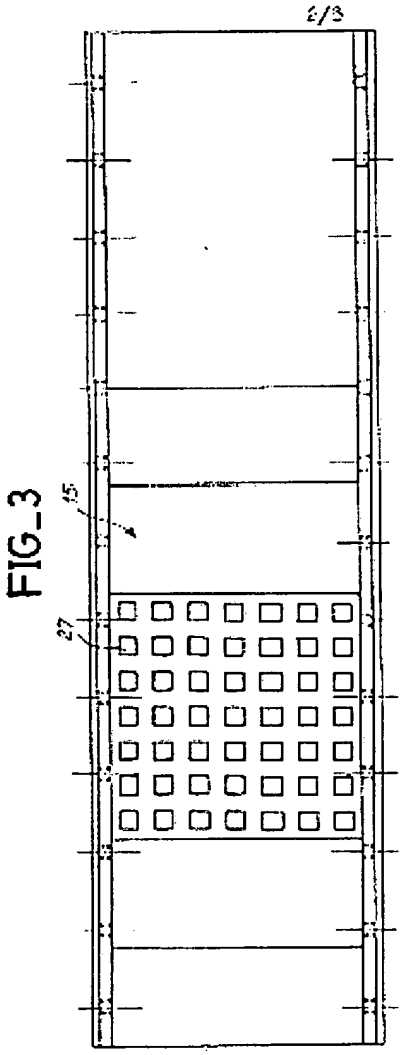


FIG_3

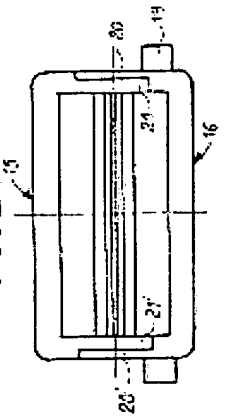


FIG_5

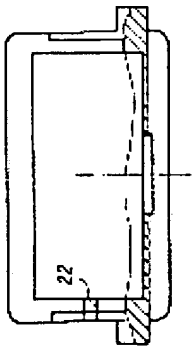


FIG_4

FIG_6

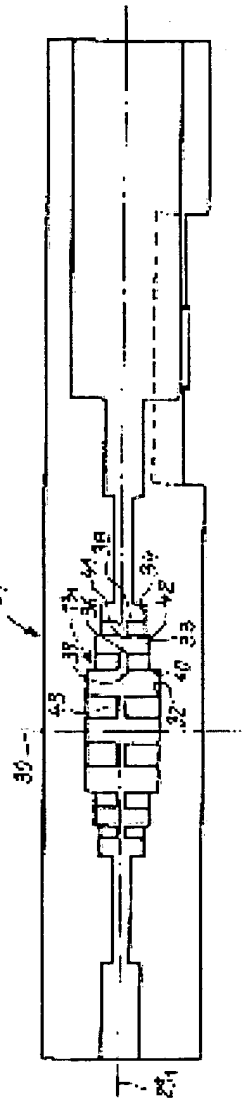


FIG_7